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Changes in Central Corneal Thickness & Intraocular Pressure after Phacoemulsification

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ABSTRACT

Objective: To determine the deviations in central corneal thickness (CCT) and intraocular pressure (IOP) after phacoemulsification.

Methodology: A descriptive observational study performed at the Institute of Ophthalmology, Liaquat University Medical & Health Science (LUMHS) Jamshoro from March to September 2022. Patients aged 45 years and above, of either gender, diagnosed with senile cataract and undergoing phacoemulsification with intraocular lens (IOL) implantation were included. Surgeries were carried out under local anesthesia using the phacoemulsification technique, followed by IOL implantation. CCT and IOP were measured before and after surgery using a pachymeter and Goldmann applanation tonometer, respectively. Postoperative follow-up were assessed on day 1, week 1, 4th week and at 6th week. All collected data were entered and analyzed using SPSS version 22.

Results: Results shows that there is 7.42% enhancement occurred in CCT on first day of surgery as compared to pre-operative mean reading, which also impacted on IOP readings that increased by 6.42% from pre-operative day. But these readings adjusted gradually. The results and findings of the research study exposed that there is not significant change occurred after surgery in CCT and IOP. Only at 1st day of surgery CCT increased due to surgical intervention due to which IOP reading is also found high and it must not be preserved until the central corneal thickness is also considered.

Conclusion: Both CCT and IOP temporarily increase after phacoemulsification, showing the most pronounced rise on the first postoperative day, but gradually stabilize with significant improvement by the first week and near-complete return to baseline by the sixth week.

Keywords: CCT, cornea, Phacoemulsification, IOP, cataract surgery, IOL

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Introduction

Age-related cataracts are the most common and largely preventable cause of blindness among the elderly, particularly in developing countries where access to timely surgical intervention and eye care services remains limited. According to the World Health Organization (WHO), cataracts account for 47.8% of all cases of avoidable blindness worldwide.[1] The fact that over 100 million people suffer from visual impairment, with a visual acuity (VA) of 6/60 or worse, underscores a significant public health concern.[2] With timely surgical intervention and appropriate optical rehabilitation, most patients with unilateral or bilateral cataracts can achieve good visual outcomes—and in some cases, even regain stereopsis. Although cataract surgery, particularly phacoemulsification, boasts a high success rate, visual prognosis in developing nations remains poor. This is primarily due to late detection, lack of diagnostic and surgical facilities, inadequate compliance with follow-up care, and limited availability of advanced equipment, especially in rural areas.

Phacoemulsification with IOL implantation is now a commonly performed surgical procedure for the management of cataracts.[3,4] Although the management of diseased eyes and the use of microsurgical instruments have improved significantly, phacoemulsification

remains stressful to intraocular tissues particularly the corneal endothelium, which lacks the ability to regenerate. Intraocular Trauma during surgery especially to inner layer of cornea, Toxicity of surgical Solutions used during intraocular surgery, surgical technique, site and size of incision, Type of intraocular lens, duration of surgery, post-operative inflammation and secondary glaucoma all are associated with changes in endothelial cell count and CCT which affects Intraocular pressure after cataract surgery. These are also been described by several Investigators.[4,5]

The corneal stroma, which is thought to be 450 um thick, accounts for the majority of the cornea's central region's average thickness of 540 um, giving an indication of the cornea's overall thickness. For the cornea to keep its clear appearance, the endothelium of the cornea is absolutely necessary. After reaching a maximum at birth (about 3,000 cells/mm^2), the cell density of the corneal endothelium continues to gradually decrease thereafter.[6] Recent studies have indicated that immediately following cataract surgery, there is a 13.81 percent increase in the thickness of the cornea's central region (at 1 hour). The difference between the pre-op values and the values on day 1 was still 6.44 percent higher, but by week 1, it had decreased to 0.57 percent.[7] Pachymetry is a helpful instrument that may readily quantify the change in corneal thickness that has occurred.[8] On other hand IOP which is a pressure generated by intraocular fluid (Aqueous) is approximately 15mmHg average and ranges from 11 to 21 mmHg. Ocular physiology and patho-physiology is connected strongly with the intraocular pressure.

Previous research has looked into an amount of issues that, after cataract surgery, can affect the patient's IOP. There is a relationship between the width of the central portion of the cornea and the IOP, with solvent corneas having lower IOP measurements and larger corneas having the potential to have higher IOP readings. This relationship is a positive one. On the other hand, structural changes such as an enlargement of the fore chamber, an enlargement of the viewpoint (angle), or a posterior capsule that shifts toward the back of the eye have been identified as potential causes of elevated intraocular pressure. These variations can happen in any of the three portions of the eye.[9] throughout the early stages of the surgical recovery phase. Increased corneal thickness in the first week after surgery can result in an artificially inflated reading for IOP in otherwise healthy eyes. This can happen even if the operation was successful in reducing the patient's IOP.[10]

The present study aims to evaluate the changes in CCT and IOP following phacoemulsification combined with intraocular lens implantation. Understanding these post-operative fluctuations is crucial, as variations in CCT can influence the accuracy of IOP measurements, potentially leading to misinterpretation or inappropriate management. By identifying the pattern and timeline of these changes, clinicians can more effectively assess patient recovery, avoid unnecessary interventions, and make informed treatment decisions. This research is particularly valuable for improving post-operative care and enhancing the accuracy of glaucoma risk assessment following cataract surgery.

Methodology

This descriptive observational study was conducted at the Institute of Ophthalmology, Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro, from March to September 2022, following approval from the Ethical Research Committee (Ref No. LUMHS/REC/37, dated 22-02-2022). Using a non-probability consecutive sampling technique, approximately 360 patients undergoing phacoemulsification with intraocular lens (IOL) implantation were expected to be enrolled during the study period, based on an average of 120 surgical cases per month.

Inclusion criteria comprised all patients aged 45 years and above of either gender with senile cataract. Exclusion criteria included patients younger than 45 years, those with follow-up of less than six weeks, cataracts associated with glaucoma, corneal opacity, or any anterior or posterior segment abnormality, as well as a history of previous intraocular surgery or intraoperative complications.

Data collection included demographic information (age, gender, and laterality) and comprehensive preoperative and postoperative anterior and posterior segment examinations using a slit-lamp biomicroscope. In cases where the posterior segment was obscured, B-scan ultrasonography was employed. CCT and IOP were measured both preoperatively and postoperatively using a pachymeter (Topcon TRK-2P) and a Goldmann applanation tonometer, respectively.

All cataract surgeries were performed under local anesthesia using the phacoemulsification technique followed by IOL implantation. Postoperative follow-up

was conducted on day 1, week 1, week 4, and week 6. Data were analyzed using SPSS version 22. Continuous variables such as age, CCT, and IOP were expressed as mean ± standard deviation, while categorical variables like gender and laterality were presented as frequencies and percentages. Paired t-tests and Chi-square tests were used for statistical analysis, with a p-value <0.05 considered statistically significant.

Results

The age range of patients in the study was 45 to 83 years. Out of 360 patients, 165 (45.8%) were female and 195 (54.2%) were male. A majority of the patients, 297 (82.5%), were from rural areas of Sindh province, while 63 (17.5%) were from urban areas. Regarding the type of cataract, 12 patients (3.3%) had bilateral cataracts, 183 (50.8%) had left-sided cataracts, and 165 (45.8%) had right-sided cataracts. Table I

Table I: Demographic data of the patients.

Variables	N	%
Gender		
Female	165	45.8
Male	195	54.2
Total	360	100.0
Residence		
Rural	297	82.5
Urban	63	17.5
Total	360	100.0
Laterality of patient's eyes		
Bilateral	12	3.3
Left	183	50.8
Right	165	45.8
Total	360	100.0

Based on internal consistency reliability for two clinical parameters, the Cronbach's alpha values indicate excellent reliability for IOP (α = 0.936) and good reliability for CCT (α = 0.865), based on five repeated items for each variable. Values above 0.7 are considered acceptable, suggesting that the measurement tools used for both parameters are statistically reliable. Table II

Table II: Reliability Statistics for IOP and CCT Measurements.

Variables	Cronbach's Alpha	N
Intra Ocular Pressure (IOP)	.936	5
Central Corneal Thickness (CCT)	.865	5

The overall reliability was high, with Cronbach's Alpha values of 0.936 for IOP and 0.865 for CCT, indicating strong consistency across repeated measurements. However, two IOP items (IOP3 and IOP4**)** showed low correlation with the total scale, suggesting they may be less reliable compared to the other readings. Most CCT items performed well, especially CCT5, which had the highest correlation with the overall score. Table III

Table III: Item-Total Statistics.

Items	Scale Mean if Item Deleted	Scale Varianceif Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
IOP1	31.54	79.703	.294	.750
IOP2	32.21	75.892	.630	.724
IOP3	31.33	83.150	.139	.764
IOP4	32.22	84.187	.131	.763
IOP5	31.54	76.845	.358	.743
CCT1	31.56	70.208	.661	.707
CCT2	29.63	70.662	.233	.785
CCT3	31.33	70.418	.553	.717
CCT4	29.68	55.039	.660	.692
CC5	30.89	61.384	.754	.678

The average total score across the 10 items was 34.66±9.35, indicating moderate variability in responses. The variance (87.43) further supports that there was some spread in the data, suggesting that while the items are generally consistent, individual responses varied to a reasonable extent. Table IV

Table IV: Scale Statistics.

Mean	Variance	Std. Deviation	N of Items
34.66	87.434	9.351	10

Preoperatively IOP and CCT values were recorded, and follow-up measurements were taken on post-operative day 1, week 1, week 4, and week 6, with a significant increase in both IOP and CCT was noted on the first post-operative day, followed by a gradual decline over the next six weeks. Till the 6th week, both parameters returned close to their baseline levels, indicating recovery and stabilization. The variability in measurements also decreased over time, showing improved consistency in corneal and pressure responses and significant difference in these changes over time **(**$p \leq 0.001$**)**. Figure 1

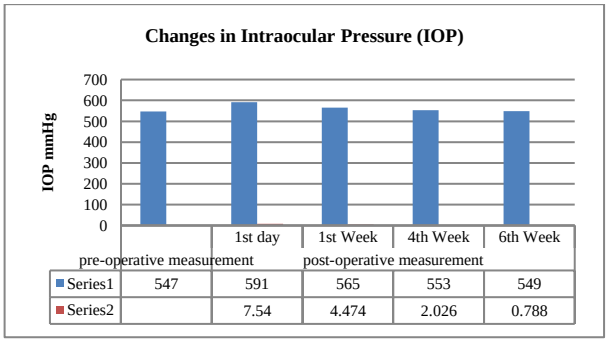

Figure 1. Changes in Intraocular Pressure. (IOP)

Discussion

Phacoemulsification may alter CCT and IOP parameters due to inflammation and surgical trauma. Pachymetry can be used not only to measure the increase in corneal thickness but also to gain further information about endothelial cell function.[11] Accurate characterization of

these changes in preexisting glaucoma or ocular hypertension is essential. This study assessed the deviations in CCT and IOP after phaco.

In present study, total 360 patients were included, with age range of 45 to 83 years and found that cataracts were more prevalent among males (54.2%) and resifing from rural areas (82.5%), with unilateral involvement being more common (50.8% left-sided and 45.8% right-sided cataracts) than bilateral, aligning with similar demographic trends reported in previous studies as the study conducted by Doss et al[12] where, 202 women from rural regions were included, with age range 50-79 years, unilateral cataract was present in 54.5% and bilateral cataract in 10.4% of patients. Consistently Gaffer IA eta l[13] included 186 individuals with cataracts, with overall mean age of 61.1 ± 11.1 years with the majority aged above 50 years (82.8%) with over half being female (51.1%) and most residing in urban areas (56.5%). On the other hand Alipour F et al[14] reported a mean age of 49.52 ± 9.31 years with a female majority (55.5%) among, whereas the present study showed a male predominance, this difference may deu to the differences in study design, sample size, demographic distribution, and selection criteria.

In this study, IOP and CCT values were significantly higher on the first post-operative day, which gradual decline over the next six weeks. CCT increased by 7.45% on first day of surgery from mean value of preoperative measurement, and this change in thickness caused 6.42% increase in IOP reading. The variability in measurements also decreased over time, showing improved consistency in corneal and pressure responses and significant difference in these changes over time ($p \leq 0.001$), indicating that phacoemulsification has a measurable and time-dependent effect on CCT and IOP ($p \leq 0.001$).

Comparable findings were reported by Wali et al[11], who observed a 10.2% increase in mean CCT values on the first postoperative day (599.42 µm) compared to the baseline preoperative value (544.96 µm). This reduced to 3.1% (565.8 µm) by the seventh postoperative day and further declined to 0.7% (548.3 µm) by the 30th day. However, they found no statistically significant difference between the preoperative and postoperative mean values, which contrasts with our findings. Hong-Kee N et al[15] also noted the CCT progressively increase, reaching its maximum one day after phacoemulsification, then gradually decreased and returned to initial levels by the sixth week in both cohorts. In alignment with these observations, Ng HK et al.[16] reported that CCT peaked on the first day after phacoemulsification and returned to baseline by the sixth postoperative week. Additionally, intraocular pressure increased sharply at two hours post-surgery and gradually declined over time, showing a significant reduction by the sixth week.

Consistently, D'Souza M et al.[17] also reported a noticeable rise in average corneal thickness on the first postoperative day (583.22 µm), which gradually decreased by the end of the first week (552.57 µm), with most eyes returning to preoperative levels (539.9 µm) within a month.

The comparison of thickness values before the operation (538.23 µm) and after one month showed no significant difference ($p=0.685$).[17] Studies suggest that CCT often increases temporarily in the early period following cataract surgery, but typically returns to baseline over time. This transient rise in CCT may lead to falsely elevated IOP readings. Therefore, elevated IOP in the immediate postoperative period should be interpreted cautiously and managed only after considering corresponding CCT values. In the study of Salvi et al[10] concluded that in comparison to preoperative baseline values, CCT increased by 13.81% at 1 hour postoperatively and dropped to 6.44% on day 1, and 0.57% at 1st postoperative week remained, however, these values consistently remained higher than the baseline levels. Moreover, they suggested that IOP may have falsely elevated during initial postoperative week in their study, explained by the increased CCT. Therefore, they did not treat all the IOPs elevated during one postoperative hour in the uncompromised healthy eyes.[18] Accordiding to the Havsar S et al[19] the median of CCT was increased significantly on day one in patients with longer phaco times but returned to stable levels by day seven.

In contrast the Elmadina AEM et al[20] reported that following the phacoemulsification, there was a significant decline in both endothelial cell density and hexagonality, while CCT showed a notable postoperative increase. However, no significant change was observed in the coefficient of variation of endothelial cell size before and after the procedure.[20]

Overall the phacoemulsification leads to a temporary increase in CCT while intraocular pressure may appear elevated in the early postoperative period due to CCT changes, suggesting a significant reduction in variability over time suggests improved corneal recovery and more stable ocular parameters as healing progresses. Present

study possess certain limitations, including a limited sample size and follow-up period and the absence of subgroup analysis, which may influence the study findings. However further studies with larger sample sizes, longer follow-up durations, and advanced imaging techniques are recommended to further explore long-term endothelial recovery and functional outcomes post-phacoemulsification. Carefull postoperative monitoring of corneal parameters, particularly among patients with pre-existing endothelial compromise, should be emphasized in clinical practice.

Conclusion

Both central corneal thickness and IOP showed a temporary increase following phacoemulsification surgery, with the most significant rise observed on the first post-operative day. These parameters gradually stabilize, with substantial recovery typically occurring within the first post-operative week and near-complete return to pre-operative values by the sixth week. The initial elevation in IOP may be influenced by a transient increase in CCT due to surgical stress, potentially leading to an overestimation of IOP readings. Therefore, early post-operative IOP measurements should be interpreted alongside CCT values to avoid misdiagnosis or unnecessary intervention. However, due to several limitations, future studies with larger sample sizes are recommended, taking into account varying environments, lifestyles, and health conditions.

References

1. Zhang B, Ding Y, Lan X. Global, regional and national burden of cataract attributable to high body mass index from 1990 to 2019. BMJ Open. 2025;15(1):e084058. https://doi.org/10.1136/bmjopen-2024-084058
2. Vision Loss Expert Group of the Global Burden of Disease Study. Global estimates on the number of people blind or visually impaired by glaucoma: A meta-analysis from 2000 to 2020. Eye (Lond). 2024;38(11):2036.
3. Chen R, Xu T, Xi C, Liu K, Hu K, Chen B. An applied study of phacoemulsification cataract surgery with the mortise and tenon limbal incision. Sci Rep. 2025;15(1):19464. https://doi.org/10.1038/s41598-025-04712-y
4. Chen KY, Chan HC, Chan CM. Do people with diabetes have a higher risk of developing postoperative endophthalmitis after cataract surgery? A systematic review and meta-analysis. J Ophthalmic Inflamm Infect. 2025;15(1):24. https://doi.org/10.1186/s12348-025-00483-9
5. Yang C, An Q, Zhou H, Ge H. Research progress on the impact of cataract surgery on corneal endothelial cells. Adv Ophthalmol Pract Res. 2024 Aug 8. https://doi.org/10.1016/j.aopr.2024.08.002
6. Chaudhry TA, Hamza M. Central corneal thickness changes after phacoemulsification. Pak J Ophthalmol. 2015;31(2).
7. Aribaba O, Adenekan O, Onakoya A, Rotimi-Samuel A, Olatosi J. Central corneal thickness changes following manual small incision cataract surgery. Clin Ophthalmol. 2015;9:151–5. https://doi.org/10.2147/OPTH.S75580
8. Cairns R, Graham K, O'Gallagher M, Jackson AJ. Intraocular pressure measurements in keratoconic patients: Do variations in IOP respect variations in corneal thickness and corneal curvature? Cont Lens Anterior Eye. 2019;42(2):216–9. https://doi.org/10.1016/j.clae.2018.11.007
9. Lv H, Yang J, Liu Y, Jiang X, Liu Y, Zhang M, et al. Changes of intraocular pressure after cataract surgery in myopic and emmetropic patients. Medicine (Baltimore). 2018;97(38): e12023.
10. Salvi SM. Central corneal thickness changes after phacoemulsification cataract surgery. J Cataract Refract Surg. 2007;33(8):1426–8. https://doi.org/10.1016/j.jcrs.2007.04.010
11. Wali FS, Surhio SA, Talpur R, Jawed M, Shujaat S. Change in central corneal thickness after phacoemulsification. Pak J Ophthalmol. 2020;36(1):67-71 https://doi.org/10.36351/pjo.v36i1.999
12. Doss MS, Kalyani P, Felix AJ. Prevalence of cataract, its risk factors and the barriers to cataract surgery among older women in a rural population of Cuddalore. Int J Community Med Public Health. 2021;8:5338–44. https://doi.org/10.18203/2394-6040.ijcmph20214268
13. Gaffer IA, Saleh RA. Demographic characteristics and associated disorders of cataract patients attended Makkah Hospital in Aden, Yemen. Electron J Univ Aden Basic Appl Sci. 2023;4(1):31–8. https://doi.org/10.47372/ejua-ba.2023.1.218
14. Alipour F, Abdi P, Asadigandomani H, Rezakhani M, Moosaie F, Jafari F, et al. Prevalence of cataracts in Iran based on the Persian Eye Cohort Study. Sci Rep. 2024;14(1):31812. https://doi.org/10.1038/s41598-024-83080-5
15. Hong-Kee N, Julieana M, Azhany Y. Central corneal thickness and intraocular pressure changes post-Phacoemulsification surgery in glaucoma patients with cataract. Ceska a slovenska oftalmologie: casopis Ceske oftalmologicke spolecnosti a Slovenske oftalmologicke spolecnosti. 2023;79(2):70-8.
16. Ng HK, Ahmad-Marwan AA, Julieana M, Chong MF, Vivian-Gong HM, Liza-Sharmini AT, et al. Central corneal thickness and intraocular pressure changes post-phacoemulsification surgery in glaucoma patients with cataract. Ces Slov Oftalmol. 2023;79(2):70–8. https://doi.org/10.31348/2023/12
17. D'Souza M, Noronha D. Changes in central corneal thickness before and after phacoemulsification cataract surgery. Clin Ophthalmol. 2020;4(4):300–2.
18. Deshpande S, Agarwal A, Shah P, Gala Y. Study of central corneal thickness before and after small-incision cataract surgery and phacoemulsification. Niger J Ophthalmol. 2018;26(1):35-39. https://doi.org/10.4103/njo.njo_30_16
19. Havsar S, Sisodiya SM, Kshatriya E**.** Central corneal thickness correlation with effective phaco time in phacoemulsification surgery at a tertiary care hospital of Gujarat, India. *Int J Health Clin Res.* 2021;1(1):41. https://doi.org/10.5455/jhspe.20211125052820\
20. Elmadina AEM, Abdelfatah RF, Alrasheed SH, Abdu M, Qureshi MA. The effect of phacoemulsification on corneal endothelial cell morphology and thickness. Pak J Ophthalmol. 2020;36(4): 428-432. https://doi.org/10.36351/pjo.v36i4.1092